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SEP 12 1991

Department of Water and Power the City of Los Angeles

September 11, 1991

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DKK
NAM
NHC
FILE

Mr. S. Gale Chapman
President and Chief Operations Officer
Intermountain Power Service Corporation
850 West Brush Wellman Road
Delta, Utah 84624-9546

Dear Mr. Chapman:

Additions and Betterments
IPSC Project File No. IGS No. 91-3
Burner Modifications and Replacements on
Units 1 and 2
Intermountain Generating Station (IGS)

As a result of our meeting on IGS boiler burners on August 8, 1991, enclosed are the minutes, revised with input from IPSC and the Department's Mechanical Engineering Section (MES), for that meeting which contain highlights and action task plans. Please proceed to do your tasks related to arranging for installation of stabilizers and shrouding for the burners of Units 1 and 2. This work should be coordinated with MES who have the lead for this team project for burner modifications. The action tasks for IPSC are as follows:

1. Arrange for Finite Element Analysis with RJM. Advise MES of status for overall schedule preparation and coordination of the activities they are responsible for.

2. Send results and recommendation of Finite Element Analysis to MES for review and to the Generation - External Major Section (GEMS) for approval.

3. Arrange for design, procurement, and installation of the stabilizers and shrouding for the Unit 2 fall scheduled outage beginning on October 28, 1991. Also, arrange for air-balancing of the burners. Coordinate the scheduling with MES.

111 North Hope Street, Los Angeles, California ☐ *Mailing address:* Box 111, Los Angeles 90051-0100
Telephone: (213) 481-4211 *Cable address:* DEWAPOLA *FAX:* (213) 481-8701

IP7_000043

4. Arrange for design, procurement, and installation of the stabilizers and shrouding for the Unit 1 spring scheduled outage beginning on April 13, 1992. This task is dependent on the successful operation of the stabilizers on Unit 2.

5. Establish the appropriate IPSC Work Orders to accumulate the costs described above related to IGS No. 91-3. Include the reestimated costs for this project in the multiyear project summary submitted in conjunction with the 1992-93 Capital Budget.

The action tasks for MES are as follows:

1. Continue the lead on this project which includes providing updated schedules, presenting cost estimates to GEMS, implementing modifications, coordinating with IPSC for those tasks IPSC is doing.

2. Review results of Finite Element Analysis arranged for by IPSC and provide recommendations to GEMS for approval to proceed.

3. As part of the team, MES will witness installation of the 48 stabilizers and shrouds on Unit 2 during the scheduled outage beginning on October 28, 1991. IPSC will arrange for the design, procurement, and installation of the stabilizers and shrouds. IPSC will also arrange for the air-balancing of the burners.

4. Perform the necessary steps to obtain 48 modified burners and install same on Unit 1 during the spring scheduled outage beginning on April 13, 1992.

5. Coordinate installation of 48 stabilizers and shrouds with the installation of the burners on Unit 1 during the scheduled outage beginning on April 13, 1992. This task is dependent on the successful operation of the stabilizers on Unit 2.

6. Investigate and, if promising, prepare a scope and cost estimate to monitor and control airflow to individual windboxes.

7. Provide an updated burner improvement program proposal to coincide with the above tasks.

The above task information should be used as a basis. Any other tasks necessary for completing the overall job should be added as necessary.

The funds presently identified in the budget are $1.819 million for fiscal year 1991-92 and $1.837 million for fiscal year 1992-93. Please provide us with cost estimates and schedules so we can update both.

If you have any questions, please contact me or Mr. Charles L. DeVore at (213) 482-7247 or have your staff contact Mr. D. Neil Boothe at (213) 481-4190 regarding budget and accounting issues and Mr. Byron H. Fujikawa at (213) 481-8740 regarding the job.

Sincerely,

Bruce E Blowey HP

BRUCE E. BLOWEY
Engineer of Generation - External

Enclosure

c: Messrs. Dennis K. Killian, IPSC
Gerald K. Hintze, IPSC
Charles L. DeVore
D. Neil Boothe
Byron H. Fujikawa

MEMORANDUM

BHF

Revised September 3, 1991

FROM B. H. Fujikawa TO C. L. DeVore DATE August 8, 1991

SUBJECT Minutes of Boiler Burner Meeting on 8-8-91

Attendees:

Chuck DeVore	Gale Chapman
Jim Allen	Dennis Killian
Larry Jones	Gerald Hintze
Byron Fujikawa	Jim Nelson
Irwin Stein	Aaron Nissen
Ron Nelson	Joe Hamblin
Doug Fowler	Joe Duwel
Raffi Krikorian	Bruce Blowey (part time)

Plans:

1. MES will continue in direction of having 48 burners installed on Unit 1 during the spring outage beginning on April 13, 1991.

2. IPSC will arrange a meeting with RJM in four weeks to answer questions from LADWP and IPSC regarding finite element analysis.

3. IPSC will ask RJM to do a finite element analysis on the present burners and operating conditions to see if their prediction indicates that the burners would have failed like they have. This run would validate the method with actual results.

4. IPSC will arrange for obtaining and installing stabilizers and shrouding for 48 burners on Unit 2 during the 4-week fall outage beginning on October 28, 1991. They will also arrange for air balancing. This is to see if the stabilizers will work as claimed by RJM.

5. IPSC will arrange for obtaining and installing stabilizers and shrouding for 48 burners on Unit 1 during the 4-week spring outage beginning on April 13, 1991 only if the stabilizers operate successfully on Unit 2. This will be coordinated with the installation of the modified burners being arranged for by MES.

6. MES will investigate and, if promising, prepare a scope and cost estimate to monitor and control air flow to individual windboxes.

7. Need to address what other tasks need doing during or after the above tasks. Need to lay out a schedule or alternative shedules to do all tasks. Need to verify that everyone can meet the windows in the schedule. Need cost estimates.

Highlights of Meeting

1. RJM given B&W modified burner design information.

2. On the present schedule, we can probably install 48 burners in the spring on Unit 1, but without the desired well thought out technical approach.

3. There are two problems associated with air. Out of service burners are not getting enough cooling air. In service burners do not have a stable flame. This may be an air flow distribution problem.

4. Can we continue for a couple of years and maintain the IGS Units until we can get a good fix? IPSC (Gale) says no for Unit 1, but yes for Unit 2.

5. RJM is seen to have a lot of experience for oil and gas burners, but is new to coal burners. There is a different swirl factor for oil, gas, and coal. Oil and gas burner units have there highest efficiency around a swirl factor of 0.6.

6. IPSC handed out their version of a schedule for handling the burner modification. MES met with GEMS earlier and presented their version. MES version copies were faxed to IPSC prior to this meeting.

7. IPSC is concerned with safety on Unit 1. They want replacement burners in the spring of 1992 no matter what we want to do in the way of R&D. According to IPSC all 48 burners on Unit 1 need to be replaced. There are holes in various parts due to high temperature. See pictures and outage book for Units 1 and 2.

8. IPSC wants to replace all 48 burners on Unit 1 during the spring outage on Unit 1. Add stabilizers also, if they prove out on Unit 2. Worst case would be to shutdown and pull the stabilizers. (Gale can live with this)

9. Put stabilizers on Unit 2 during the fall, 1991 outage. Balance air, use SS 310 material for stabilizers, and put on shrouds.

10. Need to have RJM answer some questions. A meeting was mentioned. Ron Nelson said he would like to attend.

11. For the burner material only, the cost is about $1.2 million for 310 SS and $1.8 million for 800H.

12. Could the finite element analysis method have predicted that the presently designed burners would have failed?

13. Do burner and stabilizer. Design, fabricate, and install on Unit 1 in the spring of 1992.

14. Raffi would like to try 1 burner with new material and design in November on Unit 2.

15. Raffi says B&W has not committed to 48 burners for spring, 1992.

16. Some of the costs: $350k to RJM
    For the stabilizers: $90k.
    For the 3 D modelling: $80k.
    For the air flow balancing: $45-50k.

BHF

SGC

MAR 12 1992

Department of Water and Power the City of Los Angeles

March 10, 1992

REFER
SGC
BAD 3/13/92
3-16-92
JRH 3/18/92
DKK 3/17/92
NAM 3/17/92
NHC 3-16-93
FILE

cc: M.R/D.Hud

Mr. S. Gale Chapman
President and Chief Operations Officer
Intermountain Power Service Corporation
850 West Brush Wellman Road
Delta, Utah 84624-9546

Dear Mr. Chapman:

Additions and Betterments
IPSC Project File No. 91-3
Boiler Burner Modifications and
Replacements on Units 1 and 2
Intermountain Generating Station (IGS)

As a result of our meeting on February 19, 1992 concerning IGS boiler burner modifications, IPSC is requested to perform the following tasks:

1. Inspect the Unit 2 boiler during the outage scheduled to begin on March 30, 1992 to determine the integrity of the burner stabilizers or any effects the burner stabilizers have had on the boiler. The inspection should be performed before stabilizers are installed on the new burners for Unit 1. Please ensure that Messrs. James E. Allen and Larry W. Jones from my staff and Raffi K. Krikorian from the Mechanical Engineering Section are present during the Unit 2 inspection.

2. Provide all test data and analyses showing the before and after operating conditions related to the installation of the burner stabilizers on Unit 2.

3. Perform NOx testing on Unit 2 to determine any changes in NOx emissions since the stabilizers have been added to the burners. This testing should be done and the data analyzed before the Unit 1 scheduled outage begins on April 13, 1992.

4. Baseline NOx data is absolutely required to be recorded on Unit 1 before the scheduled outage. This data will be compared to NOx data obtained after the Unit 1 outage at the same operating conditions.

If inspection or data on Unit 2 shows any severe problems caused by the stabilizers, then the stabilizers will not be authorized to be installed on the burners for Unit 1. Also, if NOx testing shows that emissions have increased on Unit 2, the stabilizers should not be installed on the burners for Unit 1.

Even if stabilizers are not installed on the Unit 1 burners, the plans for the April outage should include adding shrouding, balancing the air flow, and balancing the fuel flows. Please coordinate with the Department's Site Construction Management Group and the Mechanical Engineering Section to ensure these activities occur.

Please provide any further testing and NOx test data to me with copies to Mr. Douglas W. Fowler from the Mechanical Engineering Section and our Mr. Byron H. Fujikawa.

Enclosed for your information are the minutes of the February 19, 1992 meeting.

If you have any questions, please have your staff contact Mr. Fujikawa at (213) 481-8740 or Mr. Irwin Stein at (213) 481-6258.

Sincerely,

Bruce E Blowey/cp

BRUCE E. BLOWEY
Assistant Engineer in Charge
of Operation and Maintenance

Enclosure

c: Messrs. Dennis K. Killian, IPSC
Gerald K. Hintze, IPSC
Raffi K. Krikorian
Douglas W. Fowler
James E. Allen
Larry W. Jones
Byron H. Fujikawa
Irwin Stein

MINUTES TO BOILER BURNER MODIFICATION MEETING
HELD ON FEBRUARY 19, 1992

Attendees:

Gale Chapman	- IPSC	Raffi Krikorian	- DWP
Dennis Killian	- IPSC	Charles DeVore	- DWP
Jerry Hintze	- IPSC	Jim Allen	- DWP
Aaron Nissen	- IPSC	Byron Fujikawa	- DWP
Cecil James	- IPSC	Tom Hatton	- DWP
Bruce Blowey	- DWP	Irwin Stein	- DWP
Doug Fowler	- DWP		

A meeting was held at the GOB to discuss burner modifications to the Intermountain Generating Station (IGS) boilers. The main purpose of the meeting was to determine if test results from the Unit 2 boiler could be used to support the installation of stabilizers on the new burners for Unit 1's boiler.

Jerry Hintze gave a brief history on the burners and their modifications. Because the boiler was not able to pass the first ASME boiler test, B&W requested IPSC to operate the out-of-service burners at 1350 degrees F. At this higher temperature, the boiler was able to pass the next ASME test. However, operating at 1350 degrees F. resulted in severe damage to the burners.

B&W was never able to provide IPSC with the technical expertise to prevent the continued damage to the burners. IPSC then brought in several consultants, including RJM, to help them resolve the burner problems. IPSC felt RJM understood what was happening to their burners. IPSC believes RJM provided them with the expertise needed to resolve the burner problems. Based on RJM's advice, Unit 2's burners were modified. Coal and air balancing were conducted, and shrouding and stabilizers were installed on the Unit 2 burners during the November 1991 outage.

Air balancing test data on Unit 2 were handed out by Jerry showing before and after results. The after results indicated IPSC's adjustments did help balance the burners. Jerry also stated additional adjustments have been made to the air registers during the operation of Unit 2.

Cecil James described how RJM's finite element analysis helped B&W design a burner to withstand thermal stresses more effectively. Initially, B&W was only planning to beef up the old burner design using 800H material. He also stated the finite analysis helped reduce the cost of the new burners for Unit 1 by over $800k. MES, however, stated the savings were only around $300k. Cecil also said RJM's analysis correlated very closely with the type of damage he was seeing in the boilers.

Aaron Nissen discussed test results obtained on Unit 2 since its burner modifications. He handed out NOx and temperature data from Unit 2 testing. The NOx data compared Unit 1's emissions to Unit 2's emissions. However, the results of the test were inconclusive. The temperature data do indicate that overall temperatures of the burners have decreased. According to Aaron, because of the modifications, the burner flames have been pushed out further from the coal nozzles and the flame profiles have improved. Also, there is some indication that the eyebrow size has decreased since the outage. He also said a graph developed by RJM showed there would be an overheating problem with the new burners for Unit 1 unless stabilizers are added. IPSC concluded if stabilizers are not added to the Unit 1 burner, the new burners would deteriorate in a manner similar to the old burners. Also, there would be an additional cost for putting on the stabilizers a year later. IPSC also stated RJM made some modifications to the stabilizer design for the Unit 1 burners.

Doug Fowler stated the NOx data on Unit 2 shows the NOx emissions have gone up since the outage. He also said Operating has to decide if stabilizers are to be added to the new burners during the Unit 1 outage.

Byron Fujikawa stated that the overall temperature data was not conclusive. Individual burner temperature data showed both higher and lower temperatures after the modification. Byron also asked if there were any burner line fires in Unit 2 since the stabilizers have been added. IPSC said there had been fires but they were not related to flue gases recirculating back into the burner.

Jim Allen stated balancing the air flow is the most important aspect for ensuring the new burners are successful.

Irwin Stein stated an inspection should be done on the Unit 2 furnace to ensure there are no negative results from the stabilizers.

Bruce Blowey stated that he wants IPSC to do additional NOx testing on Unit 2. He wants to make sure that NOx levels on Unit 2 have not increased since the stabilizers have been added. He also wants Unit 2 to be inspected before the stabilizers are added to the Unit 1 burners. He said the new stabilizers can be ordered and, if there were no negative results from the Unit 2 inspection and NOx testing, the stabilizers could be installed. Bruce also stated he wants IPSC to perform baseline NOx testing on Unit 1 before the new burners are installed. He then wants the baseline Nox values to be compared to NOx test data recorded after the burners have been installed.

Charles DeVore said he would sign the paperwork to proceed with the purchase and installation of the stabilizers.

IS:hl
3-9-92

INTERMOUNTAIN POWER SERVICE CORPORATION

b2133
File: 01.03.01
14.9010 3/11 MR

March 11, 1993

Mr. Bruce E. Blowey
Assistant Engineer - Operations & Maintenance
LADWP
111 North Hope Street, Room 1255-C
Los Angeles, CA 90012-2694

Dear Mr. Blowey:

Interim Report on the Condition of Burners for IGS Units 1 and 2

Per request of Mr. Byron Fujikawa, we are writing to inform you, that to the best of our knowledge, **the burners on Unit 1 and 2 are in good operating condition and the units are operating satisfactorily at this time.**

Burner Mechanical Integrity

Based on information available to date, mechanical integrity of the flame stabilizers and burners is good. Unit 1, which has both new burners and flame stabilizers, has not yet been physically inspected. Unit 1, which is approaching one year of operation, has a major outage scheduled on April 12, 1993. Based on its performance to date, we do not expect to find any major problems. However, we plan to conduct a fireside inspection to confirm their condition.

One problem has been detected on Unit 1 with the burner tip of Burner B2. The nozzle tip has collapsed probably from overheating caused by either the loss of the air restriction shroud on the outer air register or the backplate closing off to the inner air register. This burner has been isolated from operation.

Unit 2's flame stabilizers have been inspected, after one year of operation and look in excellent condition. The damage from overheating was considerably less than found in past outages and there was only minor slag buildup on the flame stabilizers. Six nozzles tips were split at the seam weld. These nozzles had just been replaced during the previous major outage. The problem has been traced back to incorrect material and the weld technique used. Please reference the attached outage inspection sheet.

850 West Brush Wellman Road, Delta, Utah 84624 / Telephone: (801) 864-4414 / FAX: (801) 864-4970

Performance of the Burners with Stabilizers

The reason for the burner replacement and flame stabilizer installation was to address the accelerated mechanical degradation of the burners, not to improve performance. Based upon the combustion characteristics, the burners are operating the same as before the modifications. These characteristics include: NOx, LOIs, CO, oxygen levels plus eyebrow formation. Our objective, in making the burner modifications, was not to worsen any of these operating characteristics.

A concern was brought up by Mr. Irwin Stein on NOx level fluctuations in October and December of 1992, on Unit 1. Attached is a plot showing daily average emission NOx levels for both units during the second, third and fourth quarters of 1992, (period since new CEM data acquisition system available). The graph shows that there is tracking between Units 1 and 2. When Unit 1 goes up, Unit 2 goes up as well and vice versa. This indicates that whatever is effecting NOx is common to both Units such as coal quality. Even though the numbers were slightly higher than preceding months, we have seen levels that high before. They were well within compliance figures and we do not believe that they are cause for alarm.

Please note that the operating parameters of the burners and boiler are the same as before the outage. The burner front temperature alarms and secondary air windbox damper positions have not changed. We cannot envision any situation under which the addition of the stabilizers could have increased the temperature of the backplate and burner assembly. The stabilizer has pushed the flame away from the burner front (observed), and is shielding the inner air sleeve. These stabilizer characteristics have to help prevent burner damage. The actual measured temperatures at the backplates are staying below the alarm points.

It is difficult to correlate measured temperatures with success of the stabilizers because the cooling air flow to each burner has probably changed with the addition of the restrictor bands and adjustment of the backplates. The measured temperatures are single point readings that have not always been indicative of the condition of the burners. Damage has occurred previously without any indication of high temperatures.

The best indicator for the performance of the stabilizers and burners has come from the outage inspections. The inspections already conducted on Unit 2 indicate to us that the modifications have been very successful in reducing the mechanical degradation of the burners. Since Unit 1 is essentially the same, we expect the results to be similar there as well.

Summary

A final burner report will be issued after we get an opportunity to inspect the condition of the Unit 1 burners and flame stabilizers. It would be difficult to release a more in depth report on the condition of the burners without this information.

I would like to extend a personal invitation to Mr. Irwin Stein and Mr. Byron Fujikawa to come out during the Spring 1993 Outage on Unit 1 for a first hand account of the burner and flame stabilizer condition. This would be an ideal opportunity to review the modifications made to date, their success or shortcomings and recommendations for additional changes.

If you have any questions concerning this matter, please contact Jerry Hintze at (801)864-4414.

Sincerely,

S. Gale Chapman

S. Gale Chapman
President & Chief Operations Officer

AEN:dh
Attachments

cc: Byron Fujikawa
Irwin Stein

INTERMOUNTAIN POWER SERVICE CORPORATION

Engineering Test and Inspection Sheet

Sheet ___ of ___

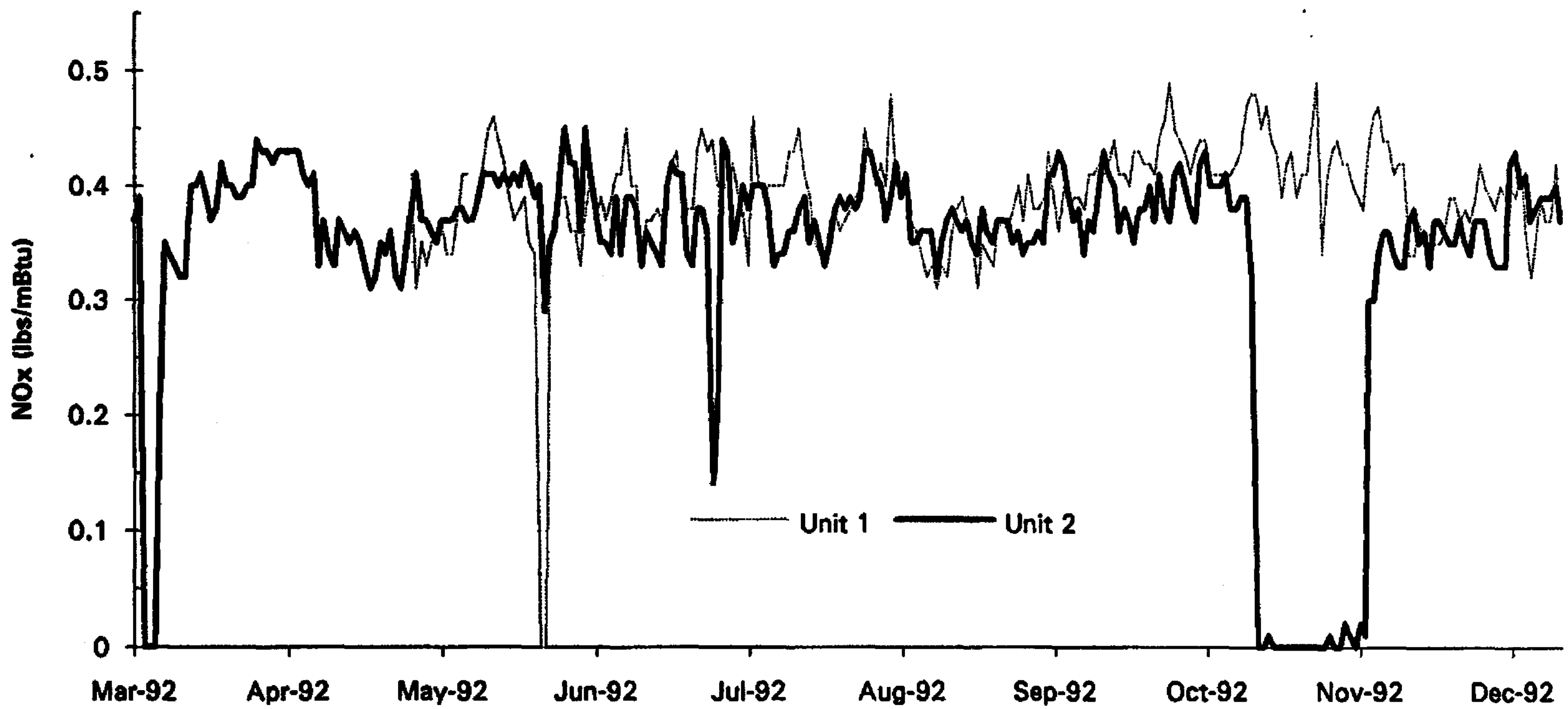
Equipment: Burner and Windbox   Unit #: 2   Test/Inspection Date: November 2, 1992

Inspector: Garry Christensen and Cecil James   Responsible Engineer (Initials): ________

Item or Test	Observations/Comments	Recommendations
All burners were inspected from the windbox side and on the fire side from the platform. The following defects and deficiencies were noted:		
B6	Small holes in the inner air sleeve just behind the back outer register plate at the 3:00 position.	Check next outage window for additional hole growth and inner air sleeve stability.
F2	The west half of the outer register has bowed back. See photo 1.	
F3	Nozzle has dropped far enough to contact the spin vanes but no the stabilizer.	Check next outage window if nozzle continues to drop and impinge on the stabilizer.
F4	The outer register has a sharp, short bow at the vane adjuster arm. See photo 2.	
A5	The nozzle has a 12 inch split at the weld seam. The nozzle has slipped behind the stabilizer's inner ring and is twisting the stabilizer as it heats and grows. See photo 3.	Nozzle replaced.
E4	The nozzle is starting to split at the weld seam.	
C6	The backplate push rod has cracked at the joint with the backplate resulting in the backplate sucking up into the inner air sleeve restricting inner air flow. See photo 4. The crack is circumferential and along the bottom half of the rod.	Rod repaired and reinforced. Install backplate hardstops on all burners so backplates will fail to a two inch air flow path.
H2	Backplate push rod failure similar to C6. The nozzle has deformed and split at the weld seam.	Rod repaired and reinforced.
H4	The nozzle tip has deformed.	
H6	The nozzle tip is starting to split at the weld seam.	
D1	Backplate push rod failure similar to C6.	Rod repaired and reinforced.

IP7_000057

INTERMOUNTAIN GENERATING STATION
Daily Emmission Averages (DEA)



INTERMOUNTAIN POWER SERVICE CORPORATION

b2263
File: 01.03.01 2/3 NMR
IGS91-3

February 2, 1994

Mr. Bruce E. Blowey
Assistant Engineer - Operations & Maintenance
LADWP
Room 1255-C
111 North Hope Street
Los Angeles, CA 90012-2694

Dear Mr. Blowey:

Intermountain Generating Station Burner Modification Report

Attached are two copies of a report entitled "Intermountain Generating Station Burner Modification Report". This report was written at the request of your staff with the purpose of summarizing changes made to the burners along with the effects on boiler performance.

If you need additional copies of this report or require further information, please contact Jerry Hintze at (801) 864-4414 Extension 6460.

Sincerely,

S. Gale Chapman

S. Gale Chapman
President & Chief Operations Officer

JKH
JKH:dh
Attachments

850 West Brush Wellman Road, Delta, Utah 84624 / Telephone: (801) 864-4414 / FAX: (801) 864-4970

Code 8701147
Rev. 9-91

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MEMORANDUM

SGC

MAR 15 1994

BEB SGC

MAR 03 1994

DeVore

MEMO BY Charles L. DeVore TO Ronald L. Nelson DATE March 1, 1994

FILE TITLE Burner Modification Report for the Intermountain Generating Station

Attached is a copy of the Intermountain Generating Station Burner Modification Report for your review and files. The report was prepared by Intermountain Power Service Corporation personnel to summarize changes made to the burners along with the effects on boiler performance. After your review, we would appreciate any comments you may have on the report by May 31, 1994.

If you have any questions concerning the report, please have your staff contact Mr. Irwin Stein on extension 70669.

IS:hl

Attachment

c: J. W. Scofield
D. W. Fowler
R. K. Krikorian
B. E. Blowey
C. L. DeVore
J. E. Allen
T. M. Ogawa
B. H. Fujikawa
I. Stein
OA File w/Attachment

IP7_000060

INTERMOUNTAIN POWER SERVICE CORPORATION

File: 01.03.10 3/8 MW
43.5801

March 7, 1994

Mr. R. Duane Chipley
Assistant Plant Superintendent
Shand Power Station
P.O. Box 1310
Estevan, Saskatchewan,
Canada S4A 2K9

Dear Mr. Chipley:

Excerpts of the IPSC Burner Report

Please find attached the excerpts you requested of our January, 1994, Burner Report. Included is the address and phone number of the flame stabilizer supplier, RJM Corporation.

If you have further questions, please contact Aaron Nissen at (801) 864-4414, Extension 6482.

Sincerely,

Dennis K. Killian
Superintendent of Technical Services

CDJ:JHN:dh
Attachment

cc: S. Gale Chapman

INTERMOUNTAIN GENERATING STATION
BURNER MODIFICATION REPORT
January, 1994

IP7_000062

SECTION 1 - INTRODUCTION AND HISTORY

1.1 Introduction

This report summarizes results of burner modifications made on Units 1 and 2 at the Intermountain Generating Station. These modifications were recommended based on serious concerns with the mechanical and structural integrity of the burners. The original equipment manufacturer, Babcock and Wilcox (B&W), did not adequately resolve structural and thermal degradation that had occurred, and was still occurring, to IPSC's satisfaction. No misoperation was documented that could have caused the degradation and the units were operated at the intended design conditions.

1.2 History

During the Unit 1 Boiler Performance Acceptance testing in 1986, it became apparent that the guarantees could not be met without making adjustments to some of the boiler parameters. The allowable temperature on out-of-service burners was changed to 1350^0 F. to lower the amount of cooling air required to protect the burner. The original setting was 1200^0 F. Soon after the change, problems were noticed with the burner structure and operation. B&W attempted to correct this problem through various design changes on Unit 1 that are summarized by year as follows:

Unit 1, November, 1986 - Repaired many failed welds, straightened warped register plates, replaced rope packing, installed reinforcing band in packing area, straightened door shafts and repaired register linkages.

Unit 1, April, 1987 - Inner air sleeves on many burners were barrel shaped and distorted. Carbon steel reinforcing bars were exfoliated, many welds broken, backplates were warped and many of the doors would not adjust. Backplate attachment was modified to try and stop warping. Three nozzle tips were replaced due to fire damage and several more showed signs of overheating.

IPSC installed 30 additional thermocouples so overheating damage could be documented and corrected (see Attachment #4, 1987 Spring Outage Inspection Report).

Unit 2, November, 1987 - B&W Construction installed new heavy duty (HD) registers on both the front and rear burners on Level Four on a trial basis to determine if the new design would allow outer register adjustment while on-line. The 22 inch alloy tips on all 48 coal nozzle assemblies were replaced with a new 33 inch alloy tip. Modifications were made to the throat and inner air sleeve attachment to the outer register frame front plates. A register retaining lug and clip system replaced the previous weld attachment. These modifications were made to eliminate recurring weld cracking and permit thermal expansion between sections of the burner register assembly (see Attachment #5, 1987 Fall Outage Inspection Report).

Unit 2, April, 1988 - Outer register vanes were trimmed in a trapezoidal shape to prevent vane binding and freezing that occurred because the backplates continued to deform (oil can). Lighter shrouds were replaced on two burners. Many welds were still found broken. Burner to waterwall seal was missing on almost all burners (see Attachment #6, 1988 Spring Outage Inspection Report).

Unit 1, April, 1989 - Even though burner backplate temperatures were maintained below the B&W recommended 1350^0 F., evidence of overheating damage was found. Permanent warping, rippling, barreling, discoloration, flaking and thermal expansion damage was observed on the heavy duty and standard outer register assemblies, register vanes, drive handles, throat sleeves, inner air sleeve casing rings and lighter shrouds.

IPSC decided that an outside consultant was needed to do an independent evaluation of the burners and estimate remaining burner life (see Attachment #7, 1989 Spring Outage Inspection Report).

Unit 1, April, 1990 - Energy and Environmental Research (EER) Corporation was hired to do an evaluation of the burners. They inspected the burners and concluded that "excessive temperatures have severely warped the stainless steel components and exfoliation of the carbon steel exists on 20 separate burners. The burners were also improperly supported which, along with the high temperature conditions, results in permanent warpage of the burners. In an effort to correct these problems, the burners received field modifications that created additional stresses." It was EER's recommendation that the burners be redesigned and replaced (see Attachment #12, EER Report).

Unit 1, April, 1991 - The burners were in the worst shape to date. William Newkirk, an ex-employee of B&W and independent consultant, came on-site to inspect the burners. He found numerous evidences of overheating. In his report he indicated that the burners only had two to five years remaining life. He raised serious concerns about a possible furnace explosion caused by overheated burners. Some of the outer air register spin vanes had gotten so hot that the steel went molten (see Attachment #13, William Newkirk Report).

1.3 Unit Description

The two Babcock & Wilcox coal fired steam generators at the Intermountain Generating Station are subcritical, single drum, opposed fired, balanced draft, parallel backend, Carolina type radiant boilers. Furnace dimensions are 85 feet wide, 60 feet deep and 229.5 feet high from the lower wall header to the drum center lines (see Attachment #3, Page 3.1, Boiler Cross Sectional View and Page 3.2, Boiler Fact Sheet).

Each unit fires pulverized coal from 48 low NO_x dual register burners, arranged in four rows of six burners on both the front and rear furnace walls (see Attachment #3, Page 3.4, Burner Arrangement Drawing). Secondary air is provided to the compartmentalized windbox by a wrap-around windbox (plenum principle). No individual burner row air flow measurement is provided.

The Mark V B&W burner is a low NO_x design, two zone burner with a conical coal diffuser. The inner and outer registers rotate secondary air flow in the same direction, with the three right hand burners spinning counter clockwise and three left hand burners rotating air flow clockwise into the furnace (see Attachment #3, Page 3.3, Burner Cross-Sectional View).

Eight pulverizers supply primary air and coal to six burners at 150 F. Normal operation requires seven pulverizers to be in-service, with the eighth pulverizer out for routine maintenance and overhauls. The seventh pulverizer is redundant and can be taken out on an emergency basis for maintenance repairs. As many as twelve burners may be taken out of service and still provide full load availability to the unit.

Coal, supplied from Utah, is bituminous, underground mined coal. Typical fuel quality is as follows:

TYPICAL COAL QUALITY

Heating Value (Btu/lb)	11850	Carbon (%)	65.0
MAF Heat Value(Btu/lb)	14275	Hydrogen (%)	4.60
Total Moisture (%)	8.10	Nitrogen (%)	1.15
Air Dry Loss (%)	6.00	HGI Index	44.5
Ash (%)	8.90	Ash Softening Temp (F)	2285
Sulphur (%)	0.45	Ash Na_2O Content (%)	1.80

The boiler maximum continuous rating of each unit is 6,600,000 lb/hr of main steam at 2640 psig at 1005 F at the superheater outlet, with a reheat steam flow of 5,285,000 lb/hr at 551 psig and 1005 F. Unit design was based on constant and variable turbine throttle pressure from 25% to 100% load. The units do not use gas recirculation for temperature or NO_x control.

Startup on Unit 1 was in February, 1986, and it went commercial on July 1, 1986. Unit 2 started up in February, 1987, and it went into commercial operation May 1, 1987.

SECTION 2 - GOALS AND PURPOSE OF BURNER MODIFICATION PROJECT

Despite all of the mechanical reliability problems that were experienced with the initial burner design, the actual operational performance of the burners remained good. Boiler performance, NO_x levels, ash loss on ignition (LOI) and flame stability were all acceptable based on the original setups. The justification for redesigning and replacing the burners was based solely on physical damage due to overheating. Modifications were not expected to improve the combustion and performance of the burners. The dual register design, originally supplied by B&W, had excellent combustion characteristics and the intent was not to deviate from that basic burner design philosophy.

The established goals and design criteria for the project were as follows:

Goal 1:
Design and install a burner that can structurally handle the operating temperatures, both in and out of service, without deformation or exfoliation. Burner registers must be operable during both in and out of service conditions. This should be done at the lowest possible cost.

Goal 2:
The new burner design should be able to operate with only minor maintenance for 25-30 years.

Goal 3:
The combustion performance and operating parameters of the burners should remain about the same or better than when they were originally installed.

SECTION 3 - PROJECT DEVELOPMENT

3.1 Discussion

With the end of the boiler warranty period, efforts began in earnest to identify alternative methods of quantifying and prioritizing the maintenance and operational impacts of the observed burner degradation. Several respected entities within the burner design/development industry were consulted.

Frequent discussions with B&W continued regarding appropriate tuning and/or modifications to correct burner degradation concerns. In one of the letters written during this period, B&W stated that without windbox flow measurement, it would be virtually impossible to achieve an air flow balance to meet both combustion and cooling requirements. Installation of B&W's proposed system for windbox airflow measurement was approximately $1,000,000 per unit.

Initially IPSC chose to involve Mr. Bill Newkirk, a retired B&W employee who, while with B&W, was responsible in large measure for the design and manufacturing quality assurance of IGS's burners. Mr. Newkirk provided meaningful information with regard to both design and manufacturing concerns. A copy of his report is attached (Attachment #13, William Newkirk Burner Report).

Based on the rate of observed burner degradation, a survey was conducted within the burner industry to select a capable firm to assess burner concerns and to provide economically based recommendations for their resolution. Energy and Environmental Research Corporation (EER) was selected to perform this evaluation. (See Attachment #12 EER Report).

EER recommended redesign and replacement of the entire register assembly, throat sleeves and casings. This report was reviewed with the original equipment manufacturer (OEM), B&W, to obtain whatever guidance they would provide. B&W responded with a new burner assembly for IGS. The new design was essentially the same burner using thicker steel, a modified throat seal and a much more expensive alloy. B&W quoted $1,600,000 per unit for the new design.

IPSC was concerned that just thicker steel sections would not enable the burner to withstand the significant thermal stresses of operation and IPSC asked B&W to perform a finite element analysis to support their new design. Their response was that a finite element analysis would serve no meaningful purpose.

In an effort to fully assess B&W's proposal and investigate our stated concerns, we felt that further outside investigation and analysis was justified. Discussions began with other sources knowledgeable in burner design and performance.

Among those consulted was RJM Corporation (RJM), a company specializing in burner performance and combustion profiling. Following on-site discussions and presentations from RJM, it became apparent that the problem was as much a function of burner design philosophy, as it was of burner stress analysis.

3.2 Proposed Solutions

A program was proposed and completed by RJM which included several parts (see Attachment #14, RJM Report):

- Aerodynamic flow evaluation of the burner that used a two-dimensional flow modeling program of air flow through the burner. This analysis established proper register settings and criteria for flame stabilizer design (see Attachment #3, Page 3.7 and 3.8).

- Secondary air flow balancing program was implemented utilizing inner and outer air zone measuring equipment.

This provided the basis for diagnosing unbalanced air flow through each burner and identify vortex generation zones.

- Structural finite element analysis was performed on the burner assembly to identify specific areas of concern at various temperatures and at various temperature ramps. A temperature grid was also generated from which "hot spot" analysis was performed to allow proper dissipation of stresses in areas experiencing the highest temperatures.

  Among the more notable results of the finite element analysis was the design of a "petal" type backplate and verification that a much lower cost alloy would be satisfactory. Based on B&W quotes dated September 12, 1991, **RJM's verification of the suitability of the 304/309 stainless steel materials versus B&W's recommended Inconel 800H, produced a savings of approximately $620,000 and cut B&W's quoted material delivery time nearly in half.** The finite element analysis cost approximately $27,000.

- To address the combustion profile and air flow concerns associated with varying register settings for balance and cooling, RJM recommended installing fixed vane 'stabilizers' at the inner air throat. Tests, both foreign and domestic, had shown this type of assembly to provide stable ignition zones and minimize the harmful recirculation effects which were consistently observed on the IGS burners (see Attachment #3, Page 3.5 and 3.6).

- Burner line restrictors were modified to ensure proper fuel and primary air flow balancing. IPSC conducted the clean air and dirty air flow testing and made the required restrictor change outs.

A team approach was established to redesign the burners. B&W assisted as OEM, RJM as design consultant and DWP's Power Design and Construction Group, assisted by IPSC, as manufacturing and installation quality control and assurance. With expedited support from DWP's Power Design and Construction Group, the modified burners were designed and manufactured in time to complete installation during the Unit 1, Spring, 1992, Outage.

3.3 SUMMARY OF BURNER DESIGN MODIFICATIONS

Modification (what)	Objective (why)	Detail (how)	Provided By (who)
Unit 2 Burner Modifications	Reduce thermal degradation	Repair existing damaged burners, add flame stabilizers, balance air flow & lineup registers	Joint: RJM/ B&W/ DWP/ IPSC
Unit 1 Burner Replacement	Reduce high rate of damage caused by thermal degradation	HD outer register assembly (hardware centered in air path), petaled backplate, material (309 SS) & thickness changes Improved throat seal	Joint: RJM/ B&W/ DWP/ IPSC
Design Review of New Burners	Cost evaluation material and thickness study	Design evaluation & finite element analysis	Joint: RJM/ B&W/ DWP/ IPSC
Flame Stabilizers	Improve flame position & stability by improving air flow dynamics	Stabilizers with fixed blade design were added to the inner air zone (between coal flow & outer air zone)	RJM
Secondary Air Flow Balancing	Balance sec air flow through the burners (inner and outer zones) [+ side-to-side, top-to-bottom & front-to-rear]	Sec air flow tested, shrouding installed on outer registers, backplates set for inner register	RJM/ IPSC

Coal Flow Balancing	Balance primary air and coal flow across the burner row	Clean air flow testing conducted and coal line restrictors added	IPSC
Improved Register Lineup	Change from trying to balance air flow with registers to positioning registers for actual flame conditions	With air balancing conducted (with shrouding and fixing backplates), plus installation of the flame stabilizers, registers could be set for flame conditions	RJM/ IPSC

SECTION 4 - RESULTS OF MODIFICATIONS

One of the primary concerns with making any burner modifications was adverse operational impact on the combustion characteristics. As stated previously, the intent of the burner modifications was to resolve the accelerated mechanical degradation, not to improve on combustion. The objective was not to allow any of the combustion parameters to get worse and to try, where possible, to improve conditions.

It should be noted that the same boiler operating parameters were utilized to operate the unit both before and after the burner modifications. These parameters include fuel-to-air ratio, excess air levels, cooling air flow requirements to out-of-service burners (i.e., same windbox damper positions) and burner front metal temperature alarms. The following sections provide performance information both before and after the modification.

4.1 Fly Ash LOI Levels

Carbon content in fly ash is generally determined by a loss on ignition (LOI) test. This test measures the percentage of weight loss that occurs by raising the ash to combustion temperatures (approx. 1500 degrees F). From a performance perspective, LOI values are not a problem until they get above 2.0 to 2.5%. Typical LOI values for IGS's units are below 1.0% which would be considered excellent throughout the industry.

When LOIs are greater than 1.0%, we feel confident we can identify and assign specific causes. For example, problems such as a nonfunctioning windbox damper, bad O_2 probe, a burner register problem, pulverizer problem (such as on a hydraulic loading skid), or a feeder calibration will cause enough of a change in LOIs to increase levels to greater than 1.0%. We consistently monitor daily and weekly LOI values and conduct regular boiler walkdowns to identify combustion problems.

Fluctuations of LOI values between 0.30 and 1.00% occur on a regular basis (reference Attachment #1, Page 1.4 for the daily Unit 1 and 2 average LOI values over the three summer months in 1993). Specific causes of these fluctuations are difficult to pinpoint. Most are caused by one or a combination of several of the following causes: coal quality fluctuations, fuel-to-air ratio fluctuations (including both coal feeder and oxygen probe calibrations), differences due to out-of-service pulverizer configurations, pulverizer performance condition (degree of wear, loading skid, or rotating throats problems), windbox damper position and other fuel and air discrepancies.

Fly ash LOI values have been extensively sampled by Pozzolanic since January, 1991. For the first two years, as many as 96 fly ash samples were collected and analyzed daily. These daily values were averaged to compute the monthly composite average (reference Attachment #1, Page 1.1 Fly Ash LOI Summary)and are summarized below:

Fly Ash Loss on Ignition Summary

	Unit 1	Unit 2	Station
LOI average over entire period (9/91-9/93)	0.72%	0.60%	0.66%
LOI average before modifications	0.65%	0.57%	0.61%
LOI average after modifications	0.75%	0.60%	0.68%
% Change	15.6%	5.8%	11.0%

This summary shows that there has been a slight increase in LOI levels since the modifications; however, this increase was within a reasonable range that still allows us to market our fly ash. The amount of ash sales has continued to increase and LOI levels are not a limiting factor. Pozzolanic sales of fly ash have steadily increased since July, 1991, and LOI's are not currently limiting ash sales. June, July, August and September, 1993, have been the highest tonnage collection months to date (Attachment #1, Page 1.5, Fly Ash Sales to Pozzolanic).

Attached are graphs of monthly LOI averages for the entire period (Attachment #1, Page 1.6). The individual monthly tally sheets for each day, unit and east and west sides, for the entire period are also included in the attachments (Attachment #1, Pages 1.7 through 1.39).

4.2 NO_x Emission Levels

NO_x emission levels were another area of major concern. Due to changes in the burner register setup and the addition of flame stabilizers, RJM was predicting an improvement in NO_x levels. Both NO_x daily emission averages and 30 day rolling averages increased slightly on both units. We believe these increases are within acceptable levels and well below State and Federal emission limits.

We did not attempt to correlate NO_x increases with other operating factors such as unit load, load variations (dispatch control), coal quality, or other parameters which impact NO_x production over the same period. Many factors determine NO_x levels such as burner register setup, fuel-to-air ratio, out-of-service cooling air flow, configuration of out-of-service pulverizers, pulverizer condition, boiler bias damper position, cleanliness of the boiler, etc. Since NO_x values are within acceptable values, major research was not conducted to determine and quantify all NO_x contributing factors and their impact.

A spread sheet was created showing the daily NO_x emission averages and 30-day rolling NO_x emission average values for the last 48 months (since 10/1/89). Daily Emission Averages (DEA) and 30-Day Rolling Averages (30-DRA) showed almost identical results, giving validity to the original data. The 30-DRA averages plus the CEM NO_x values for the 10/1/89 through 8/3/93 are included in the attachments (see Attachment #2, Pages 2.3 through 2.38).

Prior to any burner modifications, Unit 1's DEA was 0.377 lbs/mbtu (over a 31 month period) and Unit 2's DEA was 0.350 lbs/mbtu (over 25 months). After the modifications, Unit 1's DEA went to 0.385 lbs/mbtu (over 16 months) and Unit 2's went to 0.374 lbs/mbtu (over 21 months). This is a 2.1% increase in NO_x levels on Unit 1 and a 6.8% increase on Unit 2.

NO_x Daily Emissions Average (DEA) Summary

	Unit 1	Unit 2	Station
NO_x average (10/1/89-8/31/93)	0.380 lb/mbtu	0.361 lb/mbtu	0.370 lb/mbtu
NO_x average before modifications	0.377 lb/mbtu	0.350 lb/mbtu	0.364 lb/mbtu
NO_x average after modifications	0.385 lb/mbtu	0.374 lb/mbtu	0.379 lb/mbtu
% Change	2.1%	6.8%	4.4%

4.3 LOI to NO_x Relationship

The relationship between LOI's in fly ash and NO_x emissions are inversely proportionate. A decrease in excess air levels will generally decrease NO_x emission levels, but will adversely increase LOI levels in fly ash. An optimum balance was sought to maintain the lowest LOI levels possible (to meet fly ash sales obligations) and the lowest NO_x levels to satisfy State and Federal emission requirements and IPSC environmental consciousness. The original excess air targets recommended by B&W of 3.20% O_2 at full load (one pulverizer out-of-service) have been determined as the optimum.

4.4 Eyebrow Formation

Eyebrow formations above and to the sides of the burners have been an on-going problem since start-up. Evaluating the severity of eyebrow formulations is highly subjective. We had hoped to reduce eyebrow severity with the air and fuel flow balancing, but eyebrows still keep recurring. However, even with the extended outage cycle of 12 months duration, eyebrows do not interfere with burner or scanner operation.

Eyebrow problems won't totally be eliminated until coal purchased excludes coal with ash fusion temperatures below 2350^0. Approximately half of our coal purchased has ash fusion temperatures below this level. We are not recommending changing coal purchase specifications at this time, the amount of eyebrow formation does not warrant this.

4.5 Burner Front Temperatures

It has been difficult to distinguish temperature reductions on individual burners. Only within recent outages have burner thermocouples on Unit 2 been brought to a reliable status. Unit

1 thermocouples were not replaced with care when the new burners were installed, as a result, available data is not consistent. Based on the available temperature data, it is clear burner temperatures have not risen for the same windbox damper locations (i.e., same cooling air flow).

4.6 Burner Physical Inspections

Outage inspections on Unit 2 since the stabilizers were added and the air and fuel flow balanced, indicate that the rate of burner deterioration has significantly decreased. During the Unit 2 Fall, 1992, Outage Inspection (see Attachment #10) only minor problems were found with the burners. Some nozzle flaring and weld splitting was noticed at the tips, but none required change out. During the Unit 2 Fall, 1993, Outage Inspection, many nozzles were replaced due to erosion of the nozzle back at the diffuser and not to flaring or splitting. This is a new problem; previously nozzles would not last long enough to erode.

The Spring 1993 Outage Inspection on Unit 1 (see Attachment #11) showed that the new burners installed the year before were in good condition. Of particular interest was the condition of the "petaled" backplates which were found to have no signs of deformation or warpage. One of the coal nozzles was deformed and split and needed to be replaced. This burner was taken out-of-service prior to the outage because of combustion problems. Several other burners were deformed or split. In general, the amount of burner damage was minimal and many years of service should be expected from these new burners.

4.7 Burner Line Fires

Burner line fires have been noticed on both units since first operation. The fires are located in the coal transport lines in between the last elbow and diffusers. They generally occur within a few hours of initiating pulverizer operation, but sometimes they occur after days of operation. If undetected, the fires can destroy the diffuser which requires the burner be removed from service until the next outage.

All of the modifications made to the burners were in the secondary air system. Only burner line air flow balancing was done to the primary air system. Nothing was changed that would either reduce or increase the amount or severity of burner line fires.

Shortly after the modifications were made to the Unit 2 burners, it was decided to address the problem of burner line fires at the diffuser by installing temperature switches on the pipe exterior that would give an early warning to the Operators of a line fire. This would allow the Operators time to remove the burner row from service before damage was done to the diffusers. Since this warning system was installed, numerous burner line fires have occurred, but none have damaged the diffusers.

SECTION 5 - CONCLUSIONS

Based on both performance testing and inspections since installation, the new burners and associated hardware are documented to be in excellent condition. All current information supports the following conclusions:

- The Unit 1 burners should operate reliably throughout the design life of the plant.

- Degradation on the Unit 2 burners has subsided sufficiently to indefinitely postpone burner replacement.

- The nozzle flaring phenomenon is still being observed at a small number of burner nozzle tips. This problem is being monitored carefully in an attempt to correlate suspected recirculation patterns and nozzle degradation on specific burners.

- An early warning detection system installed during the 92-93 Fiscal Year has been successful in eliminating major equipment damage which previously resulted from burner line fires.

- The inner air zone turning vanes or "stabilizers", located near the burner throat, have been successful in helping stabilize flame characteristics throughout the load range. Earlier concerns regarding the long-term survivability of the stabilizers (due to overheating and/or pluggage) have proven to be unfounded.

- Balancing combustion air, by installing shrouds and stabilizers at each burner, has proven valuable. Proper cooling and combustion requires both proper volume flow and swirl in each burner zone. By allowing proper register door settings for required "swirl" control, the shrouds and stabilizers have markedly improved the consistency of the flame shape, color and ignition zone location at all loads. Elimination of inner burner degradation on Unit 1 and the significantly reduced rate of degradation on Unit 2, substantiates the improvements in airflow distribution.

- Burner combustion performance tracking shows LOI and NO_x at slightly higher levels as were seen prior to the burner modifications. Eyebrow formation and burner front temperatures are at the same levels as before any modifications. Overall, there have not been any significant changes in the combustion parameters.

- The stress analysis performed by RJM saved $1,600,000 (the cost of another set of burners). Additional burners would have been necessary when the B&W redesigned burner ultimately failed again due to thermal stress. The RJM thermal analysis also saved $620,000 by recommending different material for the new burners instead of the B&W recommended Inconel 800H. The cost of all RJM services including the 96 stainless steel stabilizers and air flow balancing was approximately $350,000.

- The approach taken to resolve the burner overheating problem was to employ all the recommendations at hand. These included flame stabilizer installation on Unit 2, new burner design assemblies with flame stabilizers installed on Unit 1, new burner lineup on the inner and outer air registers and backplate settings, secondary air flow balancing of inner and outer zones, and also primary air and coal flow balancing.

  Which modification made the largest contribution to solving the overheating problem is indeterminate; all are believed to have significantly contributed to the overall success.

To resolve the matter at hand and to avoid a lengthy testing phase, all recommendations were applied at the same time.

SECTION 6 - RECOMMENDATIONS

Based on the results of the testing and inspections, IPSC recommends the following:

1. The flame stabilizers, installed on both units, should be left in place and fully maintained.

2. The Unit 2 burners should not be replaced until additional structural degradation is observed. This degradation is likely due to thermal stresses inherent in the original B&W design.

3. When the Unit 2 burners are replaced, the design should be the same as on Unit 1.

4. The burners should be carefully inspected at each opportunity. Of particular interest is the long-term condition of the registers, stabilizers and nozzles.

5. More investigative testing should be conducted on the burner flame front position to find the causes of coal nozzle flaring. By determining where the flame fronts are located, correlations can be applied and action taken to avoid nozzles from flaring due to flame overheat.

6. Additional testing should be planned on the coal burner transport lines. A nondirectional velocity probe should be used to test dirty air (primary air and coal flow) velocities. Several different techniques have been used in the past, including clean air flow, dirty air flow and roto-probe, with conflicting results.

7. If the direct velocity measurement proves successful as hoped, an additional iteration of coal line restrictor change outs will be done if warranted.

8. No further analysis should be done on the causes of burner line fires. Since the installation of the temperature switches on the coal elbows, the damage caused by fires has greatly diminished due to early detection and intervention. If damage to the burners increases, further analysis should be done.

9. The addition of windbox air flow measuring devices is not recommended. This is no longer required due to the secondary air flow balancing that was done. Air flow balancing has resolved in-service to out-of-service (low flow to high flow) problems.

MZ Coal Flame Stabilizer

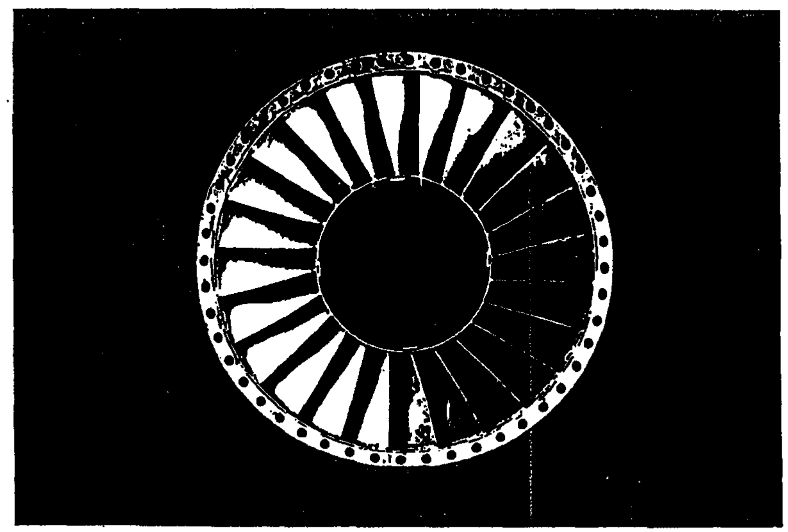

Figure 2

Correct Burner Flow Pattern

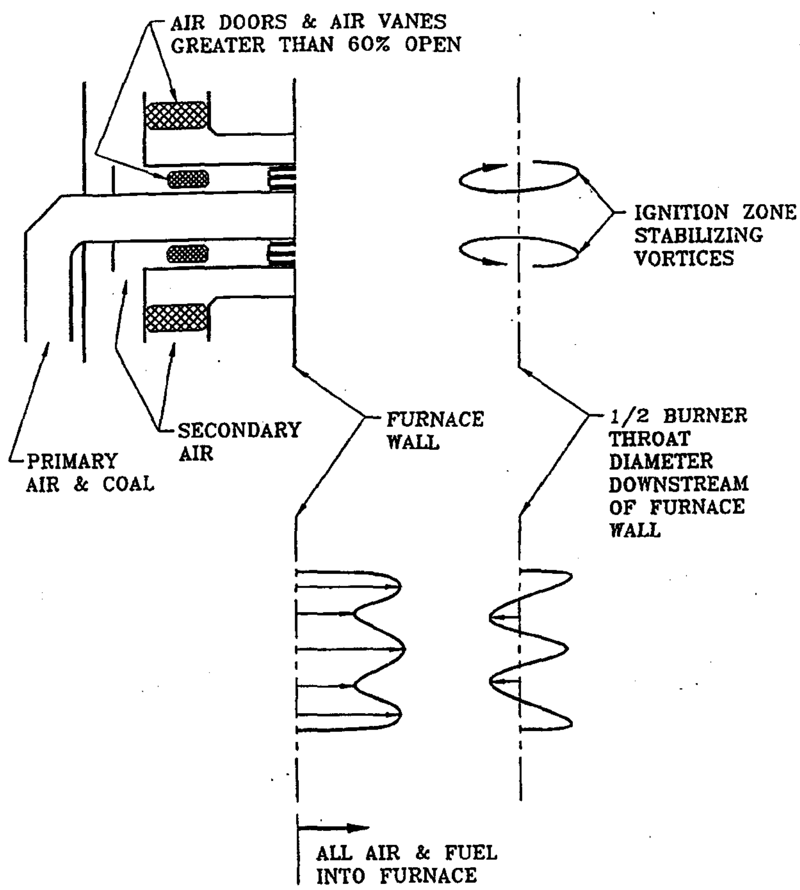

Figure 3

Burner Swirl vs. Eyebrow Formation

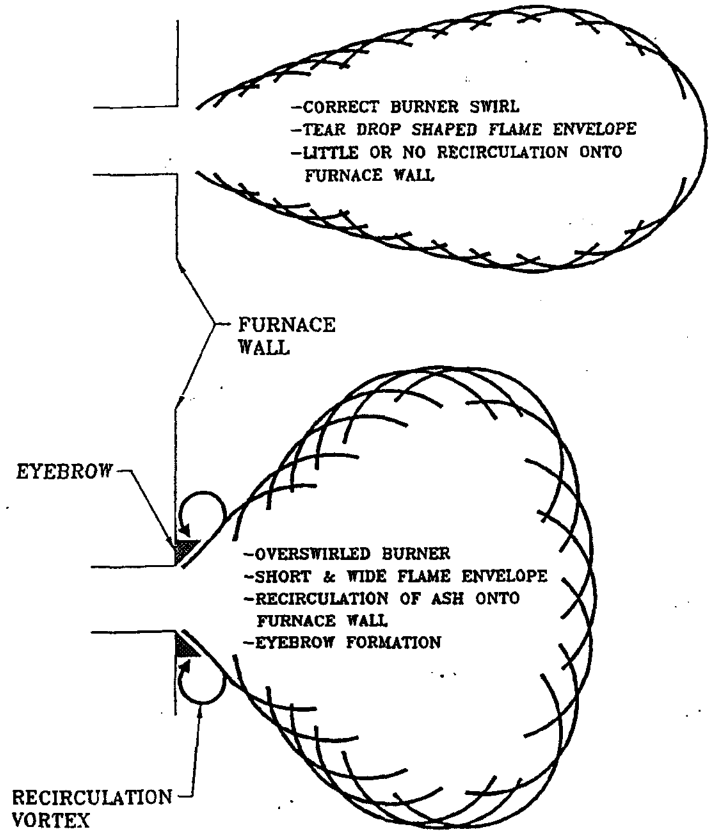

Figure 4

INTERMOUNTAIN

UNIT NO. 2 BALANCING

REPORT

for

Intermountain Power Service Corporation
850 West Brush Wellman Road
Delta, UT 84624

Attn: Mr. Aaron Nissen

Project No. 911368
January 20, 1992
Ipscunt2.rep/sv

Reliability and performance solutions

RJM

By
RJM Corporation
Ten Roberts Lane
Ridgefield, CT 06877
203 438-6198

Prepared By

Richard L. Monro

IP7_000089

Code 8701147
Rev. 9-91

B. E. Blowey
1255

MEMORANDUM

B.E.B.
SGC
MAY 25 1994

MEMO BY R. L. Nelson TO C. L. DeVore DATE May 20, 1994

FILE TITLE CONFIRMATION OF INTERMOUNTAIN POWER SERVICE CORPORATION (IPSC) COST FIGURES FOR BURNER MODIFICATION AT INTERMOUNTAIN GENERATING STATION (IGS)

In response to your memorandum of March 3, 1994, we are attaching a marked up copy of the figures for the Units 1 and 2 burner modifications at IGS.

We were able to review the costs associated with the design, fabrication, and installation of the Unit 1 burners only. The design of the stabilizers and the secondary air and fuel balancing work was administered by IPSC and we have no access to that information.

If you have any questions or if additional information is required, please contact me or have your staff contact Mr. Raffi K. Krikorian on extension 72165.

RKK:tas

R. L. Nelson

Attachment

c: w/Attachment
B. E. Blowey
T. M. Ogawa
J. E. Allen
B. H. Fujikawa
I. Stein
R. L. Nelson
R. E. Gentner
D. W. Fowler
R. K. Krikorian
94 060157 BH

BURNER MODIFICATIONS - PRELIMINARY TEST RESULTS

Unit 1 - Summary Burner Modifications:

Replacement of the Unit 1's original B&W burners in the Spring, 92 outage are summarized:

1. All original low Nox burners were replaced with new low Nox burners having a modified design to resolve certain mechanical problems. Intent of the burner changeout was to increase the mechanical life of the burners without affecting Nox levels.

Burner Fabrication Cost:	$1,582,000	
Installation Cost:	$ 100,000 ←	950,000
Consultant's Review:	$ 46,000	
Total:	$1,728,000 ←	2,578,000

2. All new burners were fitted with a flame stabilizer to mechanically resolve air flow concerns.

Stabilizer Cost:	$ 86,400
Installation Cost:	included in burner installation
Total:	$ 86,400

3. Secondary air flow balancing through the burners was also conducted. Shrouding was added to the outer air registers to vary the restriction through each burner. Back plate settings were used to balance the inner air flows. The objective was to balance the inner and outer air flows through each burner to within ±5 percent.

Test and Analysis Cost: $ 74,000

4. Fuel balancing performed by changing and/or installing new restrictors in transport lines.

Materials:	$ 54,000
Labor:	$ 21,000
Total:	$ 75,000

Total Unit 1 Expenditures: $1,963,400 ← 2,813,000

IP7_000091

BURNER MODIFICATIONS - PRELIMINARY TEST RESULTS

Unit 2 - Summary Burner Modifications:

Modifications, and their objectives, that were made to Unit 2's original B&W burners in the Fall, 91 outage are summarized below:

1. Installation of flame stabilizers in the inner zone on all 48 burners. Stabilizers were added to address burner overheat and mechanical deterioration. The objective was to significantly lower the maximum backplate temperature on the outer air registers.

Stabilizer Cost:	\$ 86,400
Labor:	\$ 40,000
Total:	\$ 126,400

2. Secondary air flow balancing through the burners was also conducted. Shrouding was added to the outer air registers to vary the restriction through each burner. Back plate settings were used to balance the inner air flows. The objective was to balance the inner and outer air flows through each burner to within ±5 percent. Perimeter loading around the burner, both inner and outer zones, was targeted for ±10 percent.

Testing and Analysis: \$ 74,000

3. Burner register settings were changed to reduce the amount of overswirl in the outer air zone and to achieve an improved flame shape. The objective was to move the flame out away from the nozzle tip, reduce the occurrence of eyebrows and prevent recirculation of flue gases back into the burner.

No Cost

4. Fuel flow balancing was also conducted which consisted of adding and changing coal line restrictors. Ten new restrictors were added and thirteen changes were made to orifice sizing on existing restrictors. These changes were made to improve fuel to air flow ratios in potentially rich or lean zones. The objective was to balance cold primary air flow to within ±3 percent. Pre and post testing was performed.

Material Cost:	\$ 23,000
Labor:	\$ 21,000
	\$ 44,000

Total Unit 2 Expenditures: \$244,400

Total expenditures for Units 1 and 2: \$2,207,800 ← 3,057,800

IP7_000092

BURNER MODIFICATIONS - PRELIMINARY TEST RESULTS

Unit 2 - Summary Burner Modifications:

Modifications, and their objectives, that were made to Unit 2's original B&W burners in the Fall, 91 outage are summarized below:

1. Installation of flame stabilizers in the inner zone on all 48 burners. Stabilizers were added to address burner overheat and mechanical deterioration. The objective was to significantly lower the maximum backplate temperature on the outer air registers.

Stabilizer Cost:	$ 86,400
Labor:	$ 40,000
Total:	$ 126,400

2. Secondary air flow balancing through the burners was also conducted. Shrouding was added to the outer air registers to vary the restriction through each burner. Back plate settings were used to balance the inner air flows. The objective was to balance the inner and outer air flows through each burner to within ±5 percent. Perimeter loading around the burner, both inner and outer zones, was targeted for ±10 percent.

Testing and Analysis: $ 74,000

3. Burner register settings were changed to reduce the amount of overswirl in the outer air zone and to achieve an improved flame shape. The objective was to move the flame out away from the nozzle tip, reduce the occurrence of eyebrows and prevent recirculation of flue gases back into the burner.

No Cost

4. Fuel flow balancing was also conducted which consisted of adding and changing coal line restrictors. Ten new restrictors were added and thirteen changes were made to orifice sizing on existing restrictors. These changes were made to improve fuel to air flow ratios in potentially rich or lean zones. The objective was to balance cold primary air flow to within ±3 percent. Pre and post testing was performed.

Material Cost:	$ 23,000
Labor:	$ 21,000
	$ 44,000

Total Unit 2 Expenditures: $244,400

Total expenditures for Units 1 and 2: $2,207,800 ← 3,057,800

IP7_000093

Code 8701147
Rev. 9-91

MEMORANDUM

94 000075 HN

SGC

MAR 15 1994

B.E.B.

MAR 07 1994

SGC

MEMO BY C. L. DeVore TO R. L. Nelson DATE March 3, 1994

FILE TITLE Confirmation of IPSC Cost Figures for the Burner Modification at the Intermountain Generating Station (IGS)

Attached are summaries of cost figures provided by IPSC. The cost figures are for IGS Units 1 and 2 boiler burner modifications. Please review the figures and confirm their correctness.

We would appreciate your review of the cost figures by April 1, 1994.

If you have any questions, please have your staff contact Mr. Irwin Stein on extension 70669.

IS:hl

Attachment

c: J. W. Scofield
D. W. Fowler
R. E. Gentner
R. K. Krikorian w/Attachment
B. E. Blowey
C. L. DeVore
J. E. Allen
T. M. Ogawa
B. H. Fujikawa
I. Stein w/Attachment
J. D. Boothe
OA File w/Attachment